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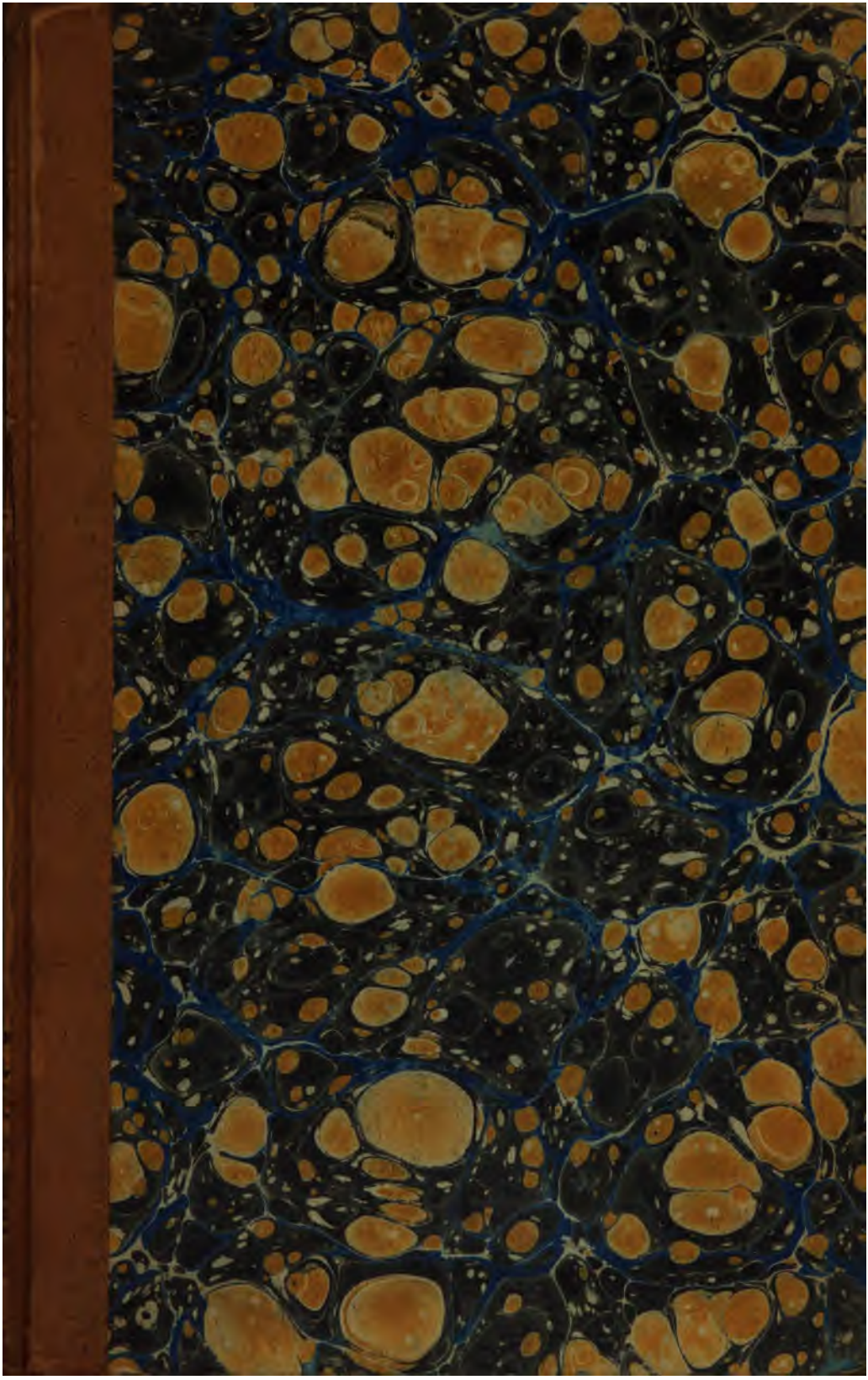

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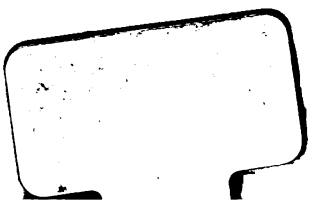

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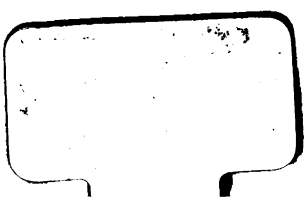
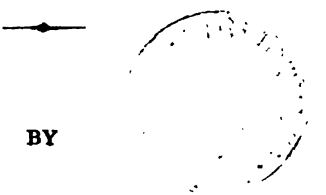


THE

NATURE AND FACULTIES

OF THE

SYMPATHETIC NERVE.



BY

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PREFACE.

It has often been a matter of regret that direct experiments can be so partially made on the Sympathetic Nerve. Its principal portions are so much connected with vital organs, and are so deeply placed, and the exposure of them is attended with such violent and fatal consequences, entirely independent of their peculiar faculties, that very little decisive information is to be obtained from the investigation. In parts more easily exposed, it has, indeed, been made to appear that a simple division of the nerve does not impair the efficiency of the rest: and experiments made more indirectly, and morbid anatomy have shown that the nerve and its ganglia may be irritated by the external and internal application of medicines, and by diseases. For appreciating the quality of its ordinary perceptions, trust must be placed in the healthy feelings of Man, as compared with those in disease, and the different effects of similar materials for food or medicine in himself and animals. For determining the extent and power of its faculties, the principal source of information must be sought for in Comparative Anatomy, when the variations in the different classes of animals

and the modified faculties in each class will be found, on due consideration, to produce some satisfactory explanations. For determining its nature, and the origin of its power, much must be left to probability; but these, if carefully considered, may tend to rational conclusions, and not be without some interesting, if not advantageous results. The information contained in the following pages has been drawn from all these sources; they are not offered as a complete history of the sympathetic nerve, but only as an addition to the Author's former observations.

Although the sympathetic nerve has always been considered as an object of interest, and has received great attention from very distinguished anatomists; its functions do not seem to have been properly appreciated. In desiring too much, or in adopting the views of celebrated men, which favor a mechanical physiology rather than those most calculated for elucidating the functions of the living body, its most obvious and useful properties have been lost sight of. If a comprehensive knowledge of it is desired, it must be obtained through sufficiently large and extended means. It is not enough for the human body, or for animals to be dissected, unless entire subjects, or large portions with the organs attached to the nerves and blood-vessels are employed, for only then can there be the opportunity of observing the size of ganglia, their ramifications, and plexuses, and their proportions to the cerebral and spinal nerves, and the several organs they supply and combine. Small parts dissected with the aid of magnifying glasses may be advantageous in clearing up points obscured by situation, delicacy of structure, and the attachment of connecting tissues; but the investigation of small parts alone, however numerous, is incompatible with suffi-

cient knowledge, and therefore must fail of leading to a full and dispassionate mode of reasoning.

Whether the sympathetic nerve is to be considered as a whole, or as supplying separate regions or single organs, its ganglia and branches must not be interrupted by too much dissection. It may be useful, as one step in Physiology, to have it carefully and minutely unravelled, to trace the various natural branches composing it to their destinations, to their connections between themselves, and to their combinations with the cerebral and spinal nerves. If the investigation has been carried beyond its legitimate boundaries, the preparation may present a vast and curious assemblage of minute nerves and ganglia, but it will be so perplexing as to produce doubts and difficulties, when they did not previously exist. If it could be conceived that such a separation of parts could exist in a living body, the object of a peculiar and combining system would have been destroyed, for many of the particular connections for sympathies and co-operations would have been severed, and divided ganglia, which, in their integrity, were constructed for the more distinct supply or isolation of particular organs, would fail of their intended purpose, and the removal of all the retiniform nervous structure would prevent the more uniform and harmonious combination, necessary in delicate or much extended organs; the removal of the neurilema, so as to make every minute fibril of a nerve appear smooth, must generally carry away connecting medullary filaments, and lead to erroneous conclusions, both in Anatomy and Physiology.

When an edifice is to be reconstructed, the skilful architect will take care not only that the several parts are removed in

order, but that they are not defaced; he will then have the power of replacing them perfect, and rendering the whole complete and useful. These observations may be applied to anatomy, for unless the investigations are carried on with a design to their uses, many objects of interest will be destroyed, and the physiologist cannot remodel them so as to form a structure that will be either safe or useful. It is not for any one to attempt to limit either the mode or extent of anatomical inquiry, but it must prove favourable to the ultimate advantages of Physiology, to pause when the results can no longer be with faithfulness determined.

Est modus in rebus; sunt certi denique fines,
Quos ultra, citraque, nequit consistere rectum.

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THE NATURE AND FACULTIES

OF

THE SYMPATHETIC NERVE.

CHAPTER I.

THE NECESSITY FOR THE SYMPATHETIC NERVE.

THERE is the same principle producing intelligence in every creature, with the addition of the mind for man, and it is conjoined through the nervous element with the medullary and cineritious matters appropriately modified; the medullary may approach to translucency, and the cineritious to a fading of the grey colour, so that in some animals there shall be no distinction between them. Each may have the usual degree of solidity lessened by the intermixture of fluid, and the thinness and quantity of the containing membrane, and by these variations the translucency will be more or less favoured, and their power in a proportionate degree diminished. The whole nervous system is formed out of these materials, and, without such simple means, it would have been impossible to have connected in one graduated scale of power the instinct or intellect, and to have placed the animal creation under the fundamental laws of the elements by which life is to be sustained, and the body to exist in freedom and ease.

Nervous Principles.

As some animals were intended to move and breathe in air, others in water, and some in both, and as it was intended that they should occupy different districts of the globe, which have peculiar conditions both with respect to heat and cold, food and shelter, each must have an appropriate structure for allowing the intellect to compass the object by which life is to be preserved. The principles of the nervous system must be accordingly modified to suit the exigencies of every animal. There must be varied proportions of medullary and cineritious matter disposed in a particular shape, or order, for constituting the centres in the brain, spinal marrow, and sympathetic system, all of which have power according to their size and complexity, and require varied nerves for connecting with them different organs. It is not sufficient for an organ to have a larger or smaller quantity of any kind of nerve, but it must be of a suitable quality, and when it is not made such through its centre, it must be modified either by varying the fibrils within itself, or by changing them in a ganglion or plexus.

Centres and Nerves.

In the animal body everything has been so arranged that the most important functions may be carried on by the simplest means, so that when the heart is set in motion, its impulses may excite various other parts, and promote the continuance of life; but as the heart is not always present, even in perfect creatures, so in the germ of these as well as in some of the lower animals, arrived at maturity, heat and other exciting powers in the atmosphere call into activity the nervous system, and afterwards promote the energies of the organs necessary for their support, and for the continuance of life. The material nervous system never acts alone; it is the receptacle of powerful agents, but only the medium for receiving and conveying impulses, and for modifying them in their course.

Animation of the Nervous System.

No change or action takes place without the interposition of one of these agents, or of some vital organ, some atmospheric influence, or some reviving materials received as nourishment.

The nervous system must be considered as the instrument of the instinct or the intellect, for controlling all the parts constituting the living body, and for soliciting beneficial, and repelling noxious influences, by acting with organs which prepare and purify the nutritious and vitalising fluids. The faculties of each animal, varied by the construction of the nervous system in connection with appropriate organs, lead it to corresponding pursuits, and these to places where nourishment can be acquired; and as the quality of the nervous system requires the use of particular food, the animal creation is necessarily distributed over different districts, and every animal finds its appropriate sort. Any particular quality for the whole would have frustrated this plan, as there would not have been enough of the same for all. Variously contrived organs, and appropriate nerves, are necessary for taking such a multiplicity of food, and preparing it for deglutition. In the four superior classes of animals, the par vagum is the principal nerve concerned in digestion, notwithstanding the shape or structure of the stomach; it may therefore be presumed that the leading feature in this process is similar in all of them. There are generally, intestines for assimilation, and the separation of the chyle from improper matters, and other organs for assisting in these processes, which require modifications of nerves. In some animals, the same nerve suffices for the entire alimentary canal as is employed in other parts of the body; but in the higher, different nerves from those of the stomach are required for the intestines, and still different ones for other organs.

Appropriate faculties for nerves and organs.

In vertebrated animals there must be an intermediate

system placed as a barrier between most of the viscera and the brain, and it must be of a peculiar conformation in different animals, otherwise it could not harmonise with the varying qualities of the centres, and viscera; without it, many of the viscera would have been perpetually communicating impulses, from their almost incessant changes, to the sensory, and interfering with the usual calm faculties of the sentient organs, the will and the intellect. For these circumstances the sympathetic nerve provides. The par vagum and sympathetic nerve are not only concerned in digestion and assimilation for the renovation of the blood, by actuating the digesting and assimilating organs, but they are also employed in the organs necessary for its purification and circulation. The par vagum, which has the highest faculties, influences digestion, and the completion and purification of the blood; the more moderate powers of the sympathetic have an intermediate office in the assimilation and separation of the chyle in the intestines, and expelling the extraneous parts, and in the circulation of the blood through the heart and arteries. As branches of both are combined for the co-operation of the several organs, it will be necessary, after the consideration of the sympathetic, to notice briefly the principal functions of the par vagum.

Necessity for the Sympathetic.

The great object of the sympathetic nerve is to furnish the parts it supplies with an appropriate nervous excitement of such a quality as will insure their functions without disturbing any other portion of the nervous system. It connects in different degrees all the parts of the nervous system as an harmonious whole, but brings them in so slight a degree in communion with the sensory as to allow only a perceptibility that can appreciate and respond to impulses

Object of the Sympathetic.

without permitting them to proceed beyond the viscera. By preventing sensation, it becomes favourable to the production of involuntary motion, so that impulses on the lining membrane of the viscera, when sufficiently strong, are responded to, and the contraction of the muscular coat takes place. For these purposes it has a peculiar conformation which differs more or less from the other parts of the nervous system. Although it communicates with several cerebral nerves, it assimilates most to the fifth and spinal nerves. From these and their centres it probably derives some of their essential or diffusive influence for fortifying its vital powers, but admits only just as much of their faculties as corresponds with the functions of the parts it supplies. It is not less extensive in any of the four superior classes of animals, in proportion to the parts it actuates, but its structure is more or less complex, and in the same degree its faculties are more distant from, or approach nearer to those of the rest of the nervous system, and accordingly are more or less independent. When its faculties are insufficient for the organs, having more complicated functions than those it generally promotes, branches of the fifth, the par vagum and spinal nerves, are combined with portions of it; or when any organs, supplied by cerebral and spinal nerves, require a more general and higher excitement from the heart and arteries, they receive more branches from the sympathetic.

CHAPTER II.

THE USES OF VARIATIONS OF ARRANGEMENT AND STRUCTURE OF THE SYMPATHETIC NERVE IN ANIMALS.

Sympathetic in different animals.

By examining the different points relating to the structure and functions of the sympathetic nerve in each class of animals the proportions, compensations, and other peculiarities, and the modifications of faculties attending them will be best understood, and the sources and uses of their leading properties will be the most satisfactorily determined.

Mammalia.

In man and mammalia, if the parts connected with the head be inquired into, without any reference to mere prominences of bone, it will appear that there is the largest superior cervical ganglion in proportion to the nerves it usually communicates with, but that it corresponds more with some branches of the carotid artery, and especially those supplying the nose and palate, than with any other parts connected with the head and face that it can be compared with. There is the largest superior thoracic ganglion in proportion to, and for supplying the vertebral artery, and for communicating with the cervical nerves. The thoracic ganglia are generally large in proportion to the intercostal nerves; they are so for supplying the aorta and intercostal arteries, and particularly for supplying the vascular rete in the porpoise as far as the middle of the thorax, but not lower down; also for connecting the nerves of the lungs with

those of the respiratory muscles, and for forming the splanchnic nerves, which are conveniently concentrated in the large semilunar ganglion for supplying the extensive viscera. The lumbar ganglia are large when a great amount of branches is sent by them to the viscera and the aortic plexus, or when the spinal nerves require to be freely connected with the heart for insuring a greater quantity of blood to the parts they supply. The sacral ganglia vary in size in man and different animals; they bear a large proportion to the spinal nerves and the extremities, and therefore, as well as on account of the small quantity of the vascular rete, do not exist, or are extremely diminutive in the porpoise. They give very small branches to the arteries and ligaments, fat and absorbents, but very large ones to be combined with the sacral nerves, and through them with the arteries of the limbs. The single ganglion exists for connecting the two chords together; in animals with tails, it is largest, and is often repeated lower down in the tail.

In birds, the small superior cervical ganglion connects the several nerves it communicates with; its proportion corresponds most with the branches of the fifth, and the arteries of the nose and palate. The usual prolongation accompanying the carotid artery is very small; the more principal chord accompanies the vertebral artery, and is attached by a small ganglion to the anterior trunk of each cervical nerve, and the whole number in proportion to the spinal marrow is more than equivalent to the large superior thoracic ganglion of mammalia, some allowance being made for the number in different birds. The ganglia of the thoracic portion are united with more or fewer thoracic spinal ganglia below the first, according to their number, so that they unite with six in the swan, and four in the golden eagle, and send off branches which form an extensive

Birds.

plexus at the sides of the vertebræ, resembling that of the splanchnic nerves in man, but it is more connected with branches of the intercostal arteries; from this plexus, in connection with the sympathetic and spinal ganglia, the small semilunar ganglia convey their power to the viscera, and communicate with the nerves of the opposite side on the cœliac and superior mesenteric arteries. Larger thoracic ganglia, and smaller semilunar, do not probably differ much from the reverse order, which takes place in mammalia, and could not be so well accommodated in birds. The other ganglia, corresponding with the lumbar and sacral, communicate with the spinal nerves by small branches; the ganglia are small, but proportionate to the uses of the kidney, lower part of the intestines, the arteries, and spinal nerves.

In amphibia, the snake has only the superior cervical ganglion, and the palatine distinct and fleshy, whilst all the rest are plexiform. There is not a ganglion in the place of the superior cervical in the turtle, but similar branches to the Vidian, and others pass upwards for the same purposes, as if they proceeded from a ganglion. From the extensive membranous, superior thoracic ganglion in the turtle, branches are sent to join the cervical nerves; in the alligator*, corresponding

Amphibia.

* The following description was taken from an alligator six feet long:—There is a small prolongation descending on the surface of the anterior cervical muscles; it communicates at the upper part of the neck with the chord in the usual canal of the vertebral artery, and then passes to join the cœliac plexus. There is a continuation of the sympathetic having numerous ganglia in the usual canal of the vertebral artery. The ganglia do not adhere to the spinal nerves as in birds, but send branches to them: they are not so large in proportion to the spinal nerves as in birds. There are ganglia in the thoracic and lumbar portions; and the thoracic adhere very much to the spinal nerves. A strong branch from the first thoracic ganglion, which corresponds with the lowest nerve entering the axillary plexus, accompanies the right portion of the vein corresponding with the superior cava, which is not in one trunk, but the subclavium and jugular of each side form a separate one, which enters at the bottom of the pericardium; it becomes mixed with branches of the par vagum, and thus corresponds in some degree with the cardiac

branches pass from numerous small ganglia attached to a prolongation in the vertebral canal, as in birds, but do not adhere to the cervical nerves as in them, but only communicate by branches. In other respects the thoracic portion in the turtle and alligator, and crocodile, is similar to that in birds, but the ganglia are smaller. The splanchnic nerves form a plexus in the place of the semilunar ganglia, and with the exception of some for the reproductive organs and tail, the distribution is similar to that in birds. The splanchnic nerves are large, but are derived from very small ganglia, or from only small plexuses attached to a slender prolongation. In mammalia, if the ganglia in the prolongation are very small, the prolongation is larger, but in amphibia it is also small.

In fishes, the first distinct ganglion sends up a branch to join the fifth, and par vagum, and after the splanchnic nerves are given off, the prolongation and its ganglia are continued downwards to communicate with the spinal nerves, give off the spermatic, and pass on each side of the aorta to the tail. Fishes.

The plan of distribution in the sympathetic, considering the various forms of the body in the four superior classes of animals,

nerves in birds; but the heart has also a large supply from the par vagum, the branches of which ramify considerably on the pericardium before they pierce it for reaching the heart. The nerves pass behind and on the pericardium, to which they adhere so firmly as to be with difficulty separated in their progress to the heart. There is a large plexus formed from the superior thoracic ganglia for the liver. Branches, proceeding from several thoracic ganglia, form a plexus about the renal capsule, instead of a semilunar ganglion, and from this and the other lumbar portion, branches are given to the ovary and oviduct, also to the intestines. There is more membrane in the plexus than in the turtle, and the branches are finer and softer, so that although it approaches nearer, it does not reach to the state of a fleshy, or close semilunar ganglion, and does not form so uniform a membranous surface as in the porpoise, pig, and others, in which there is much membrane and not much of the close fleshy ganglionic structure.

preserves a very great similarity, because it corresponds almost entirely with the fifth and spinal nerves, and is very much connected with them soon after they have emerged from their respective places of origin, so that when the skeleton is extensive, and composed of larger bones, it only makes the chord of each side longer, and placed rather more apart from its fellow at the median line. The presence of large and active extremities makes it larger, and particularly its ganglia, which communicate with their nerves. It may be broad, with very small ganglia embedded in it, and appear itself partly to furnish the nerves. It may be very small when it merely forms a connection between ganglia, or it may be double for convenience of position. When its branches can be conveniently accommodated, they pass alone, or for a safe conveyance with arteries to organs, sometimes with veins, or with excretory ducts, or in special canals. Ganglia vary according to many circumstances attending the convenience of location and function, so that they may be larger and less numerous, or smaller and more numerous, or they may be larger for higher faculties in one class, and smaller for even corresponding ones in another; several smaller ones may exist in the place of a larger one, and be equivalent in function. The leading ganglia always found in mammalia are the superior cervical, the superior thoracic, the semilunar, and often the hypogastric. In the other cervical, there are greater variations with respect to the number and size, and in the other thoracic there are variations in number and size on account of the number of ribs and spinal nerves; the lumbar and sacral vary with the number of vertebræ; their size varies with the organs placed in their vicinity. They correspond very much in size with the nerves they communicate with, and the arteries accompanying them. In the several

General disposition.

classes there are variations on account of the size of organs, their structure and functions, and some on account of the very different economy of the whole animal. A ganglion may not appear proportionate to the branches given off, as some of them proceed from the prolongation, a larger ganglion above making up the deficiency. In one part, large branches may be required for the viscera, whilst those communicating with the spinal nerves are small; on the contrary, small ones may be required for the viscera, and larger ones for the spinal nerves.

It appears, that, although there is a general resemblance, there is something peculiar in each class of animals: it is necessary, therefore, to consider the variations separately and conjointly, for no one can be taken as the certain standard whereby the results of the arrangements in all the rest are to be determined, and the consideration of the whole will tend to explain the reasons for the variations, and lead to the most probable conclusions as to the general intention of nature in the formation of the sympathetic nerve.

Variations.

In birds, none of the ganglia are equal in size to those of the largest of mammalia; compensation is, however, made by a greater number. In the alligator, there is a numerical correspondence with the vertebræ in birds, but not in the same proportion as to size; in other kinds of amphibia, as the turtle, they are much fewer, and still fewer in the snake, and, in all, much less in proportion to the spinal marrow than in birds. In fishes, the superior ganglion is large, and in all the others much smaller; the proportion of the whole to the spinal marrow is rather larger than in amphibia, unless the alligator be an exception. In all the four classes, the most superior ganglion is of the close, or fleshy character.

Proportion of Ganglia.

In mammalia, the peculiarities of conjunction between the cerebral and spinal, and the sympathetic nerves, are very few. In man, the only instance approaching the insertion of a ganglion in a nerve, is the lenticular in the branch of the third given to the inferior oblique muscle of the eye. In mammalia, there are only a few instances, and these not constant, as a ganglion attached to the Vidian nerve, and corresponding with the spheno-palatine in man, and inserted into the lateral nasal nerve; the otic ganglion to the inferior maxillary and buccal nerves; the lenticular to the nerve of the inferior oblique muscle; and into the trunk of the par vagum. In the spinal nerves there is not an example, but it joins all of them by branches. In birds, there are three kinds of communication with sympathetic ganglia, as the superior cervical, which joins the glosso-pharyngeal nerve; the other cervical ganglia, which join to the anterior trunks of the cervical nerves and first dorsal; thus including all the nerves entering the axillary plexus; thoracic ganglia, which join the ganglia of the intercostal nerves, and the communications of the lumbar and sacral ganglia by branches with corresponding spinal nerves. In amphibia, there are two kinds of communication, one between the thoracic sympathetic ganglia and spinal ganglia, the other by branches sent from them to nerves. In fishes, the connection is by branches.

Connections of ganglia with cerebral and spinal nerves and ganglia.

In mammalia, it appears, that, although the sympathetic is more complicated in having larger ganglia and plexuses, it is more distinct, and as its ganglia and those of the spinal nerves are never conjoined, the viscera are therefore more separated from the other parts of the nervous system, the sensory, and intellect. In birds, the conjunction of its ganglia with the cerebral and spinal nerves and ganglia,

Distinctive characters.

produces a more common property between them, and therefore between the viscera and the more external parts. This intermixture of two kinds of ganglia is a degradation from mammalia. In amphibia, the condition of birds is nearest approached by the alligator, but the ganglia are smaller, and do not adhere to the cervical nerves, but send branches to them; the condition of birds is next approached by turtles, and lastly by snakes. In fishes, it approaches less to the spinal nerves than in amphibia.

It has been remarked, that the sympathetic nerve in man is altogether the most complicated, but the most distinct, and that it is so in mammalia with some variations. In birds the ganglia are united not only to spinal nerves, but to spinal ganglia. In amphibia, there is a great diminution both in the number generally, and also in the size of the ganglia, and in many instances they form plexuses instead, and the sympathetic approaches the spinal nerves in texture and appearance. In fishes, there are more distinct ganglia than in amphibia, but the sympathetic is altogether more simple than in mammalia and birds. In all these instances, there is not a very remarkable decline in the disposition of the spinal marrow and its nerves, although there is some in the quality, as it and the nerves assume a softer and more translucent appearance.

Analogies between the vertebrata and invertebrata.

It may appear that the nervous system of invertebrated animals is analogous with the sympathetic of the vertebrated, and although there are external similitudes, the analogies of the spinal marrow do not cease, but only incline more to those of the sympathetic, so that the faculties are not so high as those of the spinal marrow of the vertebrated, nor so low as those of the sympathetic of amphibia,

Change in the Sympathetic.

and especially the snake. When the spinal marrow ceases to exist, the sympathetic also ceases to accompany the chord on each side, and any nerves distributed to the viscera have only a faint resemblance of it; the same elaborate intermediate system is not required, probably as the quality of the perception of the viscera differs very little from that of the chord. If any of the organs be capable of communicating impulses at variance with the rest of the nervous system, or a peculiar source of excitement is required, a special ganglion may be appended to any of the nerves, by which either the differences may be equalised, or the agency of any organ may be increased.

Qualities of Centres.

The chord of some of the highest of invertebrated animals is rather more fibrous, and the ganglia rather more solid than the spinal marrow, but the translucent appearance approaches in a considerable degree to that of some fishes, and this is undoubtedly a higher condition of the nervous system, inasmuch as it favours a more acute sensation, and probably a more active volition than the greater firmness of ganglia, and the more fibrous and nerve-like disposition of the chord, and agrees with the observation in the highest of the vertebrated, that the softer the nerves, the more exquisite are their faculties, provided there is a due quantity of medullary and cineritious matter in proportion to the membrane.

Necessity for Modification.

Changes do not take place on account of any single organ, but from modifications in the whole animal. There does not appear to be a sufficient alteration in the circulation and respiration between the highest orders of the invertebrated, and the lowest of the vertebrated, to require the absence of the spinal marrow and sympathetic, and the substitution of a chord with few, or numerous, ganglia; and although there be a heart and arteries, and only a modified form

of veins in the invertebrated, the quality of the muscular fibre of the heart, as well as of the other parts of the body, may require the modification of the nervous system. When the circulation is more contracted, the firmness of ganglia renders many animals less liable to be affected by privation, or torpidity, or exposure to the effects of the atmosphere, and various other changes incident to their low condition. The adoption of numerous small vessels for the supply of ganglia, and the power of exciting them by heat communicated to the terminal nerves, makes any impediment to the flow of blood less destructive of the vital powers, but at the same time diminishes the general excitement, which a larger accumulation of matter, having the quality of the brain and spinal marrow more copiously and uninterruptedly supplied with blood, tends to produce. Although they may in some instances have a more direct supply of blood than the ganglia of the sympathetic of the vertebrated, the activity of the system depends very little on it in numerous instances, or on any innate powers, but principally on external circumstances, as the warmth of the atmosphere, for the reception of the influence of which, ganglia are peculiarly adapted, as they can promote the vital powers when it is present, and bear to discontinue them when the heat has fallen low; it at the same time stimulates the blood-vessels with the ganglia, which act only conditionally, as well as the various organs, so that when it fails, the nerves of the skin become torpid, and when food is absent, the nerves proceeding from the ganglia to the viscera become quiescent, and the arteries abate their activity; the ganglia, nevertheless, from their peculiar construction, retain their vitality. When heat has excited the nervous system, the activity of organs, and especially the increase of the reproductive, tend to continue the various functions of the body as

long as they retain their temporary power. In this respect, it approaches the peculiarities of the sympathetic, many of the ganglia of which are brought into occasional action by circumstances, and produce a corresponding action in the blood-vessels, which ceases, and is renewed, as often as any exciting cause is presented.

CHAPTER III.

THE INNATE AND ACQUIRED POWERS OF THE SYMPATHETIC.

It will be necessary to inquire into the nature and extent of the innate faculties of the sympathetic, and the degree and manner in which these may be increased or diminished. The sympathetic contains two separate powers, a diffusive influence and a perceptive and motive faculty.

Two Powers: the diffusive influence, and the perceptive and motive faculties.

The diffusive influence, which forms the element of the material portion of the nervous system, the sympathetic nerve has the power of deriving from, and through, the cerebral and spinal nerves. It can have its powers depressed or exalted; they are depressed when those of the brain and spinal marrow are low, and especially when the spinal marrow has been permanently injured; they may be exalted in any increased vital process, whether sound or morbid. As the whole system becomes excited by new actions set up in organs entirely through the sympathetic, so may changes in the structure of ganglia, with an appropriate supply of blood, tend to exalt their condition, and that of the diffusive influence in the sympathetic nerve itself.

The diffusive influence of the Sympathetic.

The perceptive and motive faculties are concentrated in, and have their specific powers limited to, any particular region by a ganglion or plexus. The quality of the perceptive faculty depends on the structure of ganglia, the agency of which will be noticed further on; its powers are

The perceptive and motive faculties.

capable of being further exalted or depressed by the state of the diffusive influence. How far the perceptive and motive faculties are distinct from each other, is doubtful. It may be maintained that a motive action is a necessary consequence of a perceptive impulse, and the motion of the muscles depends on their peculiar structure, which only requires a sufficient stimulus for insuring its action, so that if the contents of the intestines are mild and small in quantity, they excite only the villous coat, but if irritating, they excite also the muscular. The heart has in itself apparently a far greater power than is usually derived from such small nerves as belong to it; the perceptive condition of its lining membrane is produced by its nerves, and if the peculiar irritable quality of its muscular parietes connected with its perceptive faculty is not produced by the nerves, it is controlled by them, but whether there be a distinct motive faculty, as in the nerves of the brain and spinal marrow, must remain undecided. The sparing connection of the sympathetic with the nervous system at so many different points, probably makes its faculties more gentle and less communicable in any great force to organs than they would have been, had the whole proceeded from any single part of the oblong medulla, or spinal marrow like a large nerve; the same multiplied origin makes the diffusive influence more independent and less likely to be interrupted.

Relation of the sympathetic to the spinal marrow.

Besides the nerves having different faculties, and especially the par vagum, the oblong medulla gives off the fifth nerve, which conveys both sensation and volition; it also communicates these two faculties to the spinal marrow, which has a peculiar structure for giving origin to the anterior and posterior bundles of nerves, and for the completion of their innate motive and perceptive faculties. Although the upper part is gene-

rally so large as to correspond with the lowest part of the oblong medulla, it may be very small, as in birds; but whether it be large or diminutive above, and large below, and the nerves given off few or numerous, the communication with the oblong medulla suffices for conveying sensation and volition to the whole. When it has ceased to communicate freely with the oblong medulla, it does not impart either sensation or volition, and the perceptive and involuntary motive powers it has then within itself are somewhat like those of the sympathetic, except that this may feel pain. The sentient and voluntary faculties, so well imparted to the skin and muscles through nerves and ganglia of an appropriate structure, can be countervailed by modifications in sympathetic ganglia, if the intermediate branches are considered as possessing any sensitive and voluntary properties on account of their connection with the spinal marrow. The functions of the sympathetic in the motion of the viscera following a perception, whether the person be asleep or awake, are similar to the same faculty inherent in the spinal marrow insulated from the brain. In considering the state of the spinal marrow, and its nerves in sleep, and after an injury, it is not difficult to conceive how a slight change in ganglia from the structure of the branches passing between the sympathetic and spinal nerves may prevent the communication of sensation and volition. It is not, however, intended to maintain that there is the same condition of the sympathetic in the highest classes, as in the spinal marrow insulated from the brain, for its quality is more exciting, and as far as regards the organs it supplies, it is even more so in some respects than that of the perfect spinal marrow. It only agrees with the mutilated spinal marrow in allowing involuntary motion, and in having such a perceptive quality as cannot communicate to the sensory the impulses from the

intestine motions, and actions of the organs it supplies. The quality of the faculties does not depend so much on that of the spinal marrow as on the particular structure of ganglia; the highest quality, which is most distant from that of the spinal marrow, accords with the functions of particular organs only of some animals, whilst the lowest which approaches nearest to that of the spinal marrow may harmonise with the general peculiarity of structure throughout the body, and especially the lower functions of amphibia.

Alleged origin of the Sympathetic.

It is a question whether the sympathetic is formed from the cerebral and spinal nerves, or whether it is a peculiar structure which only communicates with them. As it may be divided without any apparent inconvenience, it may be assumed that the parts above and below the division remain capable of performing their individual functions, and that the whole has a similar connection with all the cerebral and spinal nerves it communicates with, and that it does not originate from any particular centre like other nerves, but consists of a great many centres more or less powerfully or extensively connected together. The sufficiency of a chord with ganglia in the invertebrated animals, or, indeed, of one almost without ganglia, leads to the probability that the sympathetic nerve has in itself the power of performing functions independently of the spinal marrow, and that its ganglia are capable of giving and receiving impulses, and of conveying them also to other parts. The sympathetic and spinal nerves communicate only just as much as connects the sympathetic with the sensory for allowing a moderate perceptive impression to be produced, and to be capable of exaltation by any increased activity of the nervous system, or by any great excitement of the parts supplied by cerebral and spinal nerves, and, on the contrary, it can

influence the cerebral and spinal nerves by conveying either healthy or morbid excitement to them from the viscera.

Extent of independence.

Although there is an addition of a ganglion to each cervical and first dorsal nerve in birds, the chord of the sympathetic continues of the same size almost until each nerve entering the axillary plexus has been communicated with. As the chord and ganglia below are amply sufficient for supplying the splanchnic nerves, it may be concluded that each cervical ganglion is constituted almost entirely for its own uses, along with the corresponding spinal nerve it communicates with, and that the cervical portion at least, and the thoracic as far as it combines with the thoracic spinal ganglia, are not formed from the spinal nerves, but are only connected with them. It must be conceded that the sympathetic has innate perceptive powers and faculties which it conducts by branches passing from the median side of the ganglion, but it may be questioned whether those passing from the external side of the ganglion are given to or derived from the cerebral and spinal nerves. Whether the sympathetic be considered as an independent system, giving filaments to the viscera and the cerebral and spinal nerves, or whether it be considered as a tributary one receiving its supplies from those nerves, and giving branches to the viscera, there must still be the same peculiar structure for modifying it to correspond properly on the one hand with the viscera, and on the other with the cerebral and spinal nerves and their centres. If the branches are considered as passing to the cerebral and spinal nerves, some portion at least of them must be in intimate communication with these nerves, and so assimilated with them that in morbid conditions they shall convey impulses through them and the spinal marrow, or if they are passing from the spinal nerves to the ganglia they must still be able to convey

similar impulses. It is probable that according to the necessity filaments become intimately united with the spinal nerves near their origin, and that some are only in connection with them for being conducted to the arteries which terminate with the nerves in the limbs or other region, and that others join branches of spinal nerves for particular functions, as in the external spermatic of some animals, and in the thoracic of others, when the mamma is placed in either of these localities.

Enhancement of faculties.

If the sympathetic be an independent system, and have innate perceptive powers, it is not improbable that this faculty may be enhanced by its communications with other nerves, and if the ganglia are very simple and plexiform it may accept in a degree proportionate with its simplicity a share of the faculty of the nerve it communicates with; but when ganglia are of the highest order and structure, it is not assimilated to, but is more distinct from the nerves it communicates with, and then it does not accept the sensitive faculty, but only the diffusive influence. When one of its own ganglia communicates with a spinal ganglion in the thorax of birds, it will not make it more sentient, but it may give it higher power for exciting its accompanying artery to its termination and the skin itself, or when it communicates with the sentient and motive nerve combined, as in the neck of birds, it will tend to exalt the activity of the muscle also.

How far the faculties of the sympathetic may be communicated to other nerves.

In producing sympathies and combinations through its ganglia and plexuses according to their simplicity or extent, it may be a question whether besides receiving or imparting the diffusive influence it adds to or shares with them its perceptive faculty; or whether it only combines the functions of the organs it supplies with those of others whose nerves it communicates with. It may do

all, for its lower and more simple faculties allow it to amalgamate with other nerves and not interfere with their faculties, and only produce sympathies between them, and impart a higher exciting power; it may besides give to or receive from them, the diffusive influence according to their exigencies or capabilities, it may impart it to nerves of organs in present excitement or activity, and receive it from others which are at the same time quiescent, or not performing any particular function. Its peculiar faculties beyond the power of distributing the diffusive influence, are confined by ganglia or plexuses to corresponding cerebral or spinal nerves in their ordinary healthy functions, but the effect of their communication is most especially manifested in disease.

From the remarks contained in the preceding pages it appears that the sympathetic has two distinct powers, a diffusive influence and a perceptive and motive faculty; that these faculties are innate and independent, and may be exalted according to its structure, and especially that of its ganglia; that mere sensation is not a proof of high vital powers; that from the extent of the communications it has with other nerves it is capable of receiving the diffusive influence from the nervous system generally, and of communicating it through its branches to various organs, and even of enhancing its quality; that the excited and exciting powers of the sympathetic are greatest when the quantity of ganglia is largest and of the highest quality.

CHAPTER IV.

OF GANGLIA.

THE sympathetic ganglia may be divided into three orders. Each order may be divided into species, as the close or fleshy, and the open or thready. The close or fleshy have the highest quality, and the most plexiform the lowest. In the close and fleshy the filaments of nerves become intermixed with and lost in the peculiar ganglionic matter. The open or thready are formed of threads more or less interwoven, or of a plexiform or retiniform membrane, in which the membrane fills the interspaces between the threads. In the primary order the sympathetic ganglia are inserted into or are continuous with the prolongation through branches or through smaller ganglia; they may be inserted into the par vagum or into spinal nerves and ganglia, as in birds; they principally supply the bloodvessels and viscera. The secondary, as the lenticular, the spheno-palatine, and otic, probably are very little distant from the primary. The tertiary are those partaking of the arrangement and structure of both ganglia and plexuses, as the conjunction of the hypogastric plexus and sacral nerves. The tertiary have modified faculties according to their structure, and according to the quantity of each kind of nerve entering them, and only have power over the arteries in proportion to the quantity and quality of the sympathetic entering them. The fourth are the spinal, which may be confined to one order,

Classification of ganglia.

but may be divided into the same species as those of the sympathetic; they act according to their species in modifying, but still allowing the full power of sensation.

The more ganglia differ from the nerves by their close and compact structure, as in the close or fleshy ganglia, the nearer the sensitive faculty approaches the peculiar perception of the sympathetic, and the more readily they alone excite involuntary action independently of the organs receiving their branches. The more sympathetic ganglia approach the spinal nerves in plexiform ganglia, the nearer their perception approaches that of the sensitive nerves. The less, therefore, they have of the ordinary perceptive quality of the sympathetic, the less they favour involuntary motion, if the structure of the lining membrane of the viscera does not countervail their influence. Although different powers reside in the two species of ganglia, yet by the combinations of each, with organs of a peculiar structure, they only produce an appropriate influence, and a necessary activity, according to the general economy of the animal with respect to food, situation, and mode of life. Although there is some similarity in the branches proceeding to and issuing from each extreme form of ganglia, there is a decided difference in the ganglionic portion from which they emerge, but this is not greater than the modifications of function seem to require. If the most close or fleshy ganglia could be resolved into the fibrous texture of the open or thready, the peculiarity of function would cease; the two species may be made to approach each other in some slight degree by maceration and mutilation, but this would be only a deception, as their peculiar and appropriate functions must be considered according to their natural original condition, and not according to their artificial appearances.

Structure of ganglia determines the quality of faculties.

Besides ganglia, there is an approach to the open or thready in the retiniform membrane, which is an intermediate structure between ganglia and plexuses. It produces a more uniform and harmonious combination and sympathy in organs than ganglia and plexuses, and is substituted for them in some regions of many animals.

Uses of retiniform membrane.

Although spinal ganglia may be of a close and fleshy, or of an open or thready species, there is a considerable difference. As spinal ganglia derive their principal influence from the spinal marrow, and only modify the nerves in which they terminate, it may be presumed that the ganglia of the sympathetic do the same. Spinal ganglia of any animal are in proportion to the nerves entering them; sympathetic ganglia are often larger. In the spinal the nervous fibrils are never wholly obliterated, in the sympathetic they are entirely in some animals, and when they are not they approach nearer the spinal nerves. In mammalia there are both fleshy and thready spinal and sympathetic ganglia. In birds, there are only fleshy spinal and sympathetic ganglia. In amphibia, there are fleshy spinal ganglia, with very small fleshy sympathetic ganglia, or without any, except a fine plexus. In fishes, fleshy sympathetic ganglia exist both with and without spinal ganglia. Ganglia formed from the posterior bundles of spinal nerves are of different textures for modifying the nerves to the peculiarity of the skin and the other parts they supply, and allowing the several organs to harmonise with the spinal marrow and brain but these, however constituted, produce the full power of sensation, because they are equal in size to the nerves of which they are composed; the structure, nevertheless, modifies the quality. The sympathetic ganglia are much larger than the branches joining them, and therefore can have only a

Spinal and sympathetic ganglia compared.

slight sensitive quality, even if they did not in many instances undergo a much more decided change than the spinal ganglia.

There is a considerable difference between the spinal and sympathetic ganglia; for, although there may be a similar appearance of fineness or coarseness of the fibres entering them, and even in the intervening matter, there is a peculiarity of arrangement and quality in each kind; but as those of the sympathetic become more simple, they probably approach nearer to the spinal, but are never entirely the same. The ganglia of the sympathetic have more independent and higher vital powers than ganglia of the spinal nerves. Those of the spinal nerves are not independent of the brain; for, if the communication with this organ be intercepted, all the parts they supply languish when they lose the power of sensation. Ganglia of the sympathetic do not depend on high faculties of the brain, for in idiots* this system is found more developed than in sane persons.

Difference between spinal and sympathetic ganglia.

The emanation of power from ganglia in proportion to their size and structure is superior to that of plexuses. Through plexuses having extensive communications, there are larger combinations and sympathies. Combinations do not take place in the spinal marrow, but through plexuses of nerves, in which there is generally much regularity of arrangement according to the required uses of the limbs, for combining in concert the actions of the muscles. There are also smaller plexuses of cerebral and spinal nerves in connection with the muscles of the face and neck and the cutaneous muscle. Both plexuses and ganglia are used in several parts for a similar, but

Ganglia are superior to plexuses.

* Lobstein : De Nervi Sympathetici, fabrica, usu, et morbis.

modified purpose. Plexuses of cerebral and spinal nerves, having voluntary powers, act in harmony with corresponding centres in the brain, and in this respect those of the sympathetic differ from them, the influence of which, in health, is generally confined to nerves only. For the same reason, and because there is a more generally combined action of large portions, the sympathetic has a less regular distribution of ganglia and branches than the cerebral and spinal nerves.

Different opinions respecting the structure of ganglia.

There has been much difference of opinion with respect to the structure of ganglia, some asserting that they cannot be resolved into filaments, others, on the contrary, maintaining that they are entirely composed of these aggregated. Both of these assertions may be verified by comparing corresponding ganglia in man and animals, for the most fleshy have a compact and homogenous appearance, and cannot be resolved into more than a resemblance of filaments even by chemical agents, maceration, and mutilation; for the filaments entering them, or proceeding from them, are entirely blended in a peculiar substance at the centre. Other ganglia have every degree of filamentous arrangement, from the most complex aggregation to the most simple plexus.

Usual powers of ganglia may be increased.

The sympathetic nerve has a general character, properties, and power, but the arrangement and size of ganglia or plexuses, and the extent of their connections with others may limit or enlarge their energies and degree of combination with other organs. If ganglia of any region have a different structure from the rest they will modify the functions of the viscera receiving their branches. They may be larger when a higher power is required, they may be still larger in a robust person, or when organs are very energetic, or have been long irritated, and they may be smaller from opposite circum-

stances. When ganglia are smaller in mammalia, the prolongation may be larger, but in amphibia both are small and show an inferiority in the whole sympathetic.

Besides the different qualities of ganglia for producing the several degrees of exciting power, there are at the same time modifications of their perceptive faculties so that no impulse can be carried through them which does not accord with, or would disturb any of the faculties of the brain or spinal marrow, or disagree with the structure and functions of the organs of the body which are supplied by them. Ganglia are not necessary for the functions of the brain, oblong medulla, or spinal marrow, abstractedly considered, but rather for promoting the communication of impulses, except under extraordinary circumstances, and for the use of the arteries. The more enlarged the sensory, the greater is the required change of the sympathetic for lowering the sensitive faculty, unless the structure of the viscera is such as to allow only very dull perceptions. In amphibia, whose small brain is less likely to impart or receive excitement, a more liberal communication between it and the viscera may be especially required, as all the faculties, are so dull and the activity of all the organs depressed. In fishes the brain is still smaller, nevertheless a considerable change from the cerebral and spinal nerves is required in the sympathetic, on account of the peculiar structure and functions of the intestines for allowing the necessary excitement for the assimilation of acrid food, without producing any irritation of the brain and other parts of the nervous system, and therefore the ganglia are so much changed from the structure of the cerebral and spinal nerves; the change probably does not take place altogether on this account, but also for allowing a some-

Uses of degrees of the perceptive faculty in ganglia.

what higher excitement for preserving the necessary circulation of the blood.

It is very probable that the insertion of sympathetic ganglia into spinal nerves, and ganglia gives an additional power to the nerves in connection with the arteries, beyond that derived from the brain, the heart, and lungs. Thus in the par vagum, in the neck, they give power to the cardiac and pulmonary branches, and in the stomachic branches the energy is increased, according to the connection with the cœliac ganglia. The otic ganglion adheres to the inferior maxillary nerve, and the buccal in ruminants, and the parts they supply, are in almost continual action. The ganglia of the sympathetic of mammalia, and birds, preponderate very much over those of amphibia and fishes, and are undoubtedly one means of producing their higher excitement, and of increasing the power of several organs, especially of the muscles and skin.

Effect of the coalition of sympathetic ganglia with spinal ganglia and nerves.

The snake is less retentive of life than the turtle; and the whole sympathetic has less influence; it may, therefore, require a superior cervical ganglion which the turtle does not. The head of the snake may thus have higher powers and a more active circulation, not only for extemporaneous functions, but for guarding it against cold and obviating too much torpidity, and thus preserving its faculties in a more energetic condition than those of the rest of the body, otherwise the whole might soon pass from torpidity to death. The palatine ganglia are probably required not only for modifying the perceptibility of the palate, but for giving it higher powers.

Use of superior cervical ganglion in the snake.

As the ganglia of the sympathetic of the alligator are smaller in proportion to the nerves they join, and do not adhere to

the nerves as in birds, but send branches to them, they form not only a smaller, but a less intimate connection between the two, and therefore a less exciting one. This may suffice for preserving considerable action in the arteries of the head and neck for promoting the secretions of the œsophagus, and making the throat capable of allowing a more energetic act of swallowing than in snakes. Snakes have not ganglia, but their ribs afford a resistance for forming a considerable portion of a powerful canal; the spine in the alligator is much less favourable for the same purpose, and still less in birds. Turtles have not ganglia; they, however, have a powerful œsophagus, and take their food easily in small portions.

Uses of different proportions of ganglia in the neck of birds and amphibia.

On considering the nature of ganglia, it will appear that they have power according to their structure: that they are formed with relation to the organs of the body and of these with the brain; that the most compact or fleshy ganglia have the highest quality and power, and approach least to cerebral and spinal nerves in sensitive faculties; that the most open or plexiform have the lowest quality and power, and as they are less changed from spinal nerves their perception approaches nearer the sensation of the particular animal; that the fleshy, from their slight approach to sensitive nerves, have the most independent involuntary action; and the open, or plexiform, from their nearer approach to sensitive nerves, have the least involuntary powers; that the peculiarities of both these kinds may be modified by the structure of the organs receiving their branches; that the faculty of any single ganglion is indivisible, and serves for organs of different faculties, which determine the effects by their more or less irritable innate faculties; that they are not necessary for the functions of the brain and other

centres, but for preventing the communication of improper impulses to them; that they are not proportioned to muscles and several other organs, although they can enhance the power of them, when they either join their nerves, or are solely distributed to them; that as they may be absent in both vertebrated and invertebrated animals, when similar organs are present, they are not absolutely necessary, but only for promoting their required modifications of functions.

CHAPTER V.

PARTICULAR PROCESSES INFLUENCED BY THE SYMPATHETIC.

ONE of the most permanent powers of the sympathetic consists in regulating the arterial system, and particularly the arteries of the brain, the spinal marrow, and the nerves. It is principally in connection with the arterial system that the object of its distribution can in many instances be understood, especially in its sparing supply to some nerves, and its larger one to others, which do not appear to differ in power, and therefore probably convey some portion of the filaments they receive to the conjunctions of their own branches with the terminal arteries. Its diminished sensitiveness is well adapted for these circulatory functions. In man and mammalia, in which the brain is large, the action of the heart requires to be steady and to a considerable degree independent, also in birds; it is therefore supplied very much by the sympathetic. If it had received common sentient nerves, it would have been too much and too easily excited by external circumstances, and consequently the blood would have been circulated irregularly throughout the body, especially in the nervous system, and would have impeded their functions, whilst the heart would have been reacted on by their disorder, and particularly that of the intellect; also by the exertion or excitement of various parts of the body. In amphibia it is not sufficiently exciting for the heart, and therefore the par vagum gives this organ many branches by which it is brought in a greater

Power of the sympathetic over the circulation.

degree under the influence of the brain. There is probably the most energetic circulation where there is the largest proportion of ganglia of the highest order and quality, and in the branches proceeding from them. In different classes of animals the circulation may be greater according to the structure of the heart and arteries, according to the supply the heart receives from the par vagum, and according to the quantity and quality of the branches derived from ganglia of the sympathetic. In mammalia it is influenced by modifications of all these, also in birds. In amphibia it has a lower power notwithstanding the supply from the par vagum; there is a comparatively small quantity of sympathetic ganglia even in the highest order, and the spinal ganglia do not appear to exert much influence. In fishes generally it continues more energetic throughout all seasons than in amphibia, if the alligator and some others may be excepted.

Sympathetic ganglia are supplied from very small contiguous arteries, which are only connected through slender vessels running along the prolongation; the circulation of blood in them is very moderate, until they are excited by the commencing activity of the organs they supply. They may have their functions modified according to the quantity and quality of the blood they receive; so that independently of their structure in amphibia, they have less excited powers on account of the less degree of oxygenisation of the blood as well as on account of the arrangement of vessels; and in the same manner in various states of higher animals in which the blood is not freely changed, either from the low degree of natural healthy functions, or from those which are disordered.

Circulation in ganglia.

Besides the excitement communicated to the vascular system from the sympathetic itself, there may be a general one through

the influence of external agents on the senses, or through internal ones from the passions and intellect; it may take place through the general diffusive nervous influence, and be communicated to the whole sympathetic; or it may take place through particular tracts of the spinal marrow, and affect one portion of the sympathetic more than another and corresponding arteries. It particularly regulates the arteries of the brain, spinal marrow and nerves, in which there is a connected circulation, for although they have blood from numerous arteries, there is a free communication between them, and they are all under its direction. Its faculties are generally gentle and quiet, unless they are altered by the excitement of other parts, and even then the arteries are not acted upon so impetuously as they would have been if they had been supplied by the cerebral or spinal nerves.

Effect of cerebral and spinal nerves in the circulation.

When the intestines are in activity, the nerves become excited, and with them the arteries, so that there is a larger determination of blood to them for increasing their vital and perceptive powers, for producing the proper secretions, and finishing the process of the conversion of the chyme into chyle. Although the perception is heightened, it is of such an agreeable character as not to provoke the expulsive powers of the muscular coat, unless the food is so coarse, or has undergone such changes as especially irritate it. In other organs which co-operate with the intestines by communications of nerves, the arteries become excited for soliciting an increased supply of blood for heightening their activity and promoting their secretions. Even when different nerves are conjoined for the functions of secreting organs, the arteries and other parts must be combined in the same action and the same function, particularly when secretion is taking place. The sympathetic

Functions of nerves and arteries combined.

probably suffices for the blood-vessels and secreting parts of the liver, although there is a conjunction of branches of the par vagum in many animals for combining it with other organs. The stomach also receives branches of the sympathetic for its arteries, and of the par vagum for its general functions, but they are very much conjoined, so that any excitement of the stomach from the presence of food can stimulate the arteries; they are also combined especially for the duodenum, whilst the functions of the greater portion of the intestines depend principally on the sympathetic, and part of the colon on it alone; the testis and ovary, and the kidney and their blood-vessels, also depend on it alone. As when chyme is admitted into the intestines, the excitement from its presence is communicated by the nerves of the viscera to the ganglia, and from these to the arteries, which are thus brought into full activity for maintaining the condition necessary for assimilation and the required secretions, if the faculties of the ganglia were separate, and the viscera and arteries received nerves which were independent of each other, this necessary sympathy and co-operation would not take place. It is presumed that all the branches connected with any ganglion partakes of one and the same property, inasmuch as the ganglion actuates all the parts supplied, according to their peculiar structures, and combines them together for one common function and purpose.

General quiet state of ganglia.

Ganglia of the sympathetic preserve a state of quietude, when they are not called upon to perform any higher functions than preserve just sufficient circulation of blood for the easy condition of the whole body, so that they continue in a somewhat passive state until they have a call upon them for their energy. When they have received a sufficient impression, and have become excited, and along with them the

arterial system generally, they then only impart sufficient energy for producing an extemporaneous high condition of healthy functions, but if they receive excitement from a more permanent cause, as mercury, arsenic, disordered viscera, or external wounds, they assume a continued morbid irritation. Then they can transmit by the communicating cerebral and spinal nerves to the parts these supply, inordinate impulses producing ailments of the skin, pain in parts supplied by sensitive nerves, and spasms in those receiving motive nerves.

As the heart and arteries are originally formed to have a degree of action proportionate with the sympathetic nerve, unless this be properly encouraged it will fail of sustaining the activity of the heart and arteries; but if it be over-stimulated, it will excite them beyond their regular power, and produce either premature growth or morbid enlargement of organs. The sympathetic is often attenuated in delicate subjects, and may have degenerated from want of due encouragement, or from proper nourishment, and therefore it cannot support the necessary action for the growth of the body, which becomes in consequence diminutive or deformed. It is the same in animals as in the human body; and therefore, for securing their full growth and fatness at a determined period, it is found advantageous to support them without interruption from birth to maturity with a plentiful supply of mild nutritious food. As the ganglia in the young are generally large in proportion to the body, they sustain a brisk circulation and assimilation, and favour the growth of the body. If food too stimulating is given, the heart and arteries may be excited beyond their healthy vigour required for the organs—there will then be inordinate action; on the contrary, narcotics stifle the nervous power, and do not allow of sufficient action. If there has been an uninterrupted

Powers of the sympathetic encouraged.

supply of proper nourishment, the body will become robust, and the sympathetic will retain an ordinary healthy size until the decline of life, when it may gradually become attenuated according to the slowness of the waste of the other parts. If the body be kept in moderate activity, the exercise of all the other parts of the nervous system will tend to invigorate that of the sympathetic by its sharing with them some portion of their energy; but if the exertion be immoderate, it may be maintained by stimulating food for some time, but sooner or later the sympathetic and the organs it supplies will cease to bear this state of over-excitement, and disease probably will be the consequence. If the healthy condition of the sympathetic nerve is to be preserved, and the comfortable feelings thereby determined, moderation in diet must be one of the principal means.

Similar ganglia for various functions, through the modification of organs.

As ganglia having a similar structure serve for various degrees of peristaltic action in different animals, and others of a different structure for the same, it may seem as if the structure of ganglia did not signify much; nevertheless, it tends to produce the necessary degree of activity in connection with the varying condition of the structure of the alimentary canal and other organs. In some instances it is necessary to retain the food longer in the small intestines, on account of the slow assimilation and absorption of the chyle; in others it is necessary to carry it quickly to the capacious cœca, or to favour a quick elimination of the remains. In some of these the alimentary canal, from its structure, or from a more excitable condition of the nervous system, admits of a more acute perception, whilst in others the powers of both are so dull and low as only to allow a very slight impression from the same exciting cause. Modifications of ganglia are therefore required for corresponding with and allowing those changes. Without

such variations the intestines would not be adapted to the quality or quantity of food, its transmission might be inadequate, the supply of blood might be inordinate, or the secretions not properly made.

It is probable that the impression made on the intestines in their sound condition cannot be appreciated by the sensory as a sensation, whatever may be the structure of ganglia. Man from his own perceptions may with some degree of probability determine the influence of ganglia, which have a similar structure to his own; also those of their modifications in animals, an allowance being made for the difference of organs and the general powers of the nervous system. In many animals, it may be observed that proper food is soothing and agreeable during its assimilation and absorption, but that acrid kinds produce irritation, and things still more obnoxious cause violent pain, heat, and inflammation. These circumstances are much more conclusive respecting the perceptive power of the sympathetic than experiments made by cutting, pricking, or other modes of irritating the nerves, when their influence cannot be made clearly manifest, as other structures and nerves must necessarily be involved in the operation. If the sympathetic could have transmitted ordinary impressions to the spinal marrow as sensations, its object of separating the viscera from the brain in healthy functions would have been defeated, and the muscles supplied by the spinal nerves would have been liable to unnecessary action. If the bladder had been supplied by the sympathetic only, and the irritation from the urine had spread from the nerves of the bladder to those of the abdominal muscles for its evacuation, the action would have been very uncertain; it might sometimes have been almost continual; at others it might have been delayed until extreme distension took place, and then it

Quality of the perceptions of ganglia.

might have approached too near that of the uterus in parturition, or of the stomach in vomiting; and therefore sensitive and motive nerves have been added to those of the sympathetic for directly supplying the bladder with an independent power for this purpose.

The insertion of sympathetic ganglia into spinal nerves may tend to increase the muscular power along with the action of the arteries. In the cervical nerves of birds they increase the activity of the carotid and vertebral arteries, and the actions of the terminal branches of the arteries and nerves at their connection with the muscles and skin, whose powers they thus favour. Although the mechanism of the bones and ligaments tends to preserve the upright position of the neck, the muscles must become weary—and especially in flight—without some compensation. The muscles of the wings have great force and quickness of action, and require for this purpose a higher innate power than either the muscles, or their nerves, or the will supply. Wings are not used in some of the same species, whilst they are very much in others: in the former, the powers of the ganglia are then confined to the organs of supply, as they are not required for promoting the activity of muscles, and consequently favour the deposition of more inert matter, as fat. If similar ganglia are found in birds not fitted for flying, the rudiments of wings and other parts usually connected with them may act in a subsidiary manner to the legs, and expedite their faculties by facilitating the action of the muscles in preserving the necessary position of the head along with the other cervical nerves and muscles, for balancing it on the trunk in running. In the lumbar region, the ganglia of the sympathetic communicate with the spinal nerves by branches. This mode of construction probably forms a smaller and less intimate connec-

Power of ganglia in increasing muscular action.

tion between the two, and therefore a less powerful and exciting one; and it may suffice for this purpose, as the shock on the contact of the feet alternately on the ground in running, or even in the water in swimming, is a source of excitement much greater than the force of the air on both the extended wings. The energy in birds is very great, and it is not improbable that the connection of so many ganglia with spinal nerves and arteries may tend to produce the untiring activity of the muscles. The persistence of the action of the heart in connection with the supply of nerves from the sympathetic and par vagum countenances this opinion.

The sympathetic exercises great influence over the cutaneous functions; the larger communications of ganglia with spinal nerves makes the skin more susceptible of an increased action of the vascular system, and thus enables it to sympathise with any great excitement of the viscera of the chest and abdomen; it also promotes the growth of wool, hair, and feathers. It is not enough to have a skin formed for producing a peculiar kind of wool or hair, but there must be sufficient energy maintained in the heart and arteries through proper ganglia of the sympathetic, for keeping up a necessary degree of activity in the cutaneous arteries and nerves. If therefore bad food, or a scanty supply of good food, is used, or assimilation fails so that the animal is ill nourished, the functions of the sympathetic suffer, and especially those influencing the arteries and the more passive parts depending on them, and particularly the skin; so that if this organ does not become diseased there may be bad or deficient wool, or hair or feathers.

Influence of the sympathetic on the skin.

Whatever increases the circulation, at the same time produces a larger evolution of heat. Ganglia of the highest order and quality therefore exercise considerable influence over it, and when

they are joined to spinal ganglia, or cerebral or spinal nerves, they promote it in the highest degree, as in birds. Many birds have to encounter greater changes of temperature than their covering of feathers is fitted to withstand: many also require an uninterrupted source of heat for incubation. In cetaceous animals ganglia are employed along with the vascular rete, as part of the means for keeping up the necessary excitement and heat, for countervailing some effects of the medium in which they live, and particularly in preventing a too great determination of blood to the viscera.

Evolution of heat.

There has been much difference of opinion respecting the production of the heat of animals. It has been considered to depend on the brain, or on the spinal marrow, or on the par vagum and other nerves, or on respiration and several other processes. It is not improbable that all these powers may combine in its evolution, and not any of them separately; but centres and nerves must be in conjunction with the organs, and the processes of these must be considered as the result of the whole acting in unison. The removal, or injury, or impediment of any of these organs may at the same time impair the powers of the sympathetic, and especially those of the minute arteries, none of which circumstances have been taken into the account. It is remarkable that the heart is largest in such animals as have the largest proportionate quantity of sympathetic ganglia of the highest quality, in combination with the spinal nerves and the ramifications of arteries. If the united action of the arteries, by a greater supply of blood in connection with the nerves, disposes to the production of heat, and the sympathetic ganglia to their activity, these must at least indirectly promote its evolution. If the ganglia were large without a heart proportionate in size and perfection, they probably would

The source of heat.

not do more than takes place in the several orders of amphibia. Neither ganglia, nor arteries, nor any organs or processes, act alone in its production, but several combined; for the blood, besides the impetus and quantity in which it is transmitted, must be freely oxygenised in the lungs, and must pass through them with sufficient quickness for enabling the large heart to send a continued and regular supply for the whole system. Whenever the body receives a great shock, whether from the mind or external or internal changes, there is a general depression: it seems as if the diffusive nervous influence was almost expended, and then the heart is also depressed.

When exercise is taken, the action of the heart, and the excitement of the sympathetic, prevent the effect of external cold. The sentient nerves have some share in this; but it is in reality not so great as it may seem, for they can even then have their powers diminished or impeded. The action of the muscles, and the excitement this produces, may, indeed, have some influence in enabling the skin to resist the cold; but it is principally through the sympathetic and par vagum, on the circulatory and respiratory organs; but even the powers of these flag sooner or later, according to the exhaustion of the general nervous influence. The heart is weary, and the respiratory actions feeble, so that the nervous system becomes congested; there is a weariness and gradual exhaustion of the powers of the cerebral matter, of the powers of the muscles, and of the sentient organs, and in this condition sleep is favoured. Although the skin of the higher classes is influenced by external heat, the internal organs and vital powers do not depend much on it. When the heart and brain are small, the power of continuing exertion becomes less, and is further easily depressed in amphibia, by cold, probably more than in fishes,

Effect of exercise.

whilst birds and mammalia generally resist a great degree of cold; but some allowance must be made for the means by which their bodies are defended, through hair, &c.

The plexiform conjunctions in the place of ganglia in amphibia, do not admit of much excitement; it is, however, such as is adapted for promoting the functions of the viscera and blood-vessels. As all the perceptions of the viscera are dull, as well as those of the sensory, a very distinct intermediate system is not required, and probably not more than harmonises any difference between them and the skin and spinal marrow and brain, so that the sympathetic may approach the spinal nerves, and allow impulses to be conducted to the spinal marrow from the viscera, almost as if they proceeded from the skin. These small ganglia, and prolongation, and the simple construction of the sympathetic generally in amphibia, accords with a slow circulation and assimilation of food, and does not allow of any great excitement, except from the heat of the atmosphere, on which they depend more for an increase of functions at particular seasons than on the inherent powers of the body; in this respect the lowest approach the invertebrated; the highest are more excitable, and depend less on external circumstances. In the more ravenous kinds of amphibia, probably the larger size of the par vagum, and the peculiarity of the stomach, and a somewhat higher respiration and circulation, enable them to dispose of a larger supply of blood, which is necessary for preserving the more constant activity. The heart has chiefly branches from the par vagum, and not from ganglia, as in mammalia, for providing a higher excitement than that allowed by the sympathetic. In the alligator, the heart is supplied with more branches of the sympathetic than in the turtle, and has a larger share of ganglia in

Decline of power with the plexiform sympathetic.

the sympathetic for giving branches to accompany the nerves and arteries; therefore, as the arterial system has a supply of more exciting nerves, it does not depend so much for its action on the heart; and this organ, therefore, does not require the large assistance from the par vagum. It corresponds in these respects with the arrangement in birds, probably also in energy, but still in an inferior degree. Although the faculties of amphibia are dull, and their condition depends in some degree on the smallness of the ganglia, larger ones would not coincide with the low quality of their organs, and, therefore, would be prejudicial. Plexuses for the viscera produce an inferior quality of excitement, but this accords with a slow respiration and circulation, and promotes assimilation and absorption sufficiently fast for the means of disposing of the chyle in the ordinary state of the system. But when the body is put in activity, and the circulation is quickened, there will be an increase of their functions, and a more active assimilation.

From the observations on the sympathetic nerve of animals, it may be concluded, that mammalia and birds have the greatest energies; then some of amphibia and fishes; and that the several variations of the sympathetic, and their combinations with other nerves, accord very much with the vital powers of each class and order of animals, in connection with the comparative perfection of the heart and respiratory organs; for neither the brain, the oblong medulla, the par vagum, nor the spinal marrow, can exert much influence, without a supply of properly oxygenised blood, and the heart, at least in the highest classes, cannot act very long without the exciting power derived from the sympathetic.

The sympathetic accords with the vital powers.

The sympathetic nerve has several properties peculiar to itself, and some resembling the faculties of other nerves. It is

to a certain extent, an independent system, and is a source of peculiar power. It derives its general diffusive influence, or nervous element, from the other parts of the nervous system its branches communicate with. It has appropriate faculties, and is perceptive, and not sensitive, except in pain. Its ganglia have a power according to their structure, and a capability of receiving and answering impulses. It excites involuntary motion primarily. If the impulses are strong, but still amount only to a perception, the ganglia can transmit them to the spinal marrow, and thence directly to the voluntary muscles; but if the impulses be stronger, and amount to pain, they may pass from the spinal marrow to the brain, and excite voluntary motion; or they may pass from the ganglia to the stomachic plexuses, and from these by the par vagum to the oblong medulla, and thence to the spinal marrow and its nerves, and produce vomiting. It, and especially its ganglia, have a peculiar circulation of blood by minute vessels, derived from contiguous parts, which is quiet and gentle, and increased by the activity of the organs its branches supply; it may also be increased by excitement communicated through the nervous influence, or tracts, or nerves, from the brain, and other centres, the intellect, passions, and external senses. It presides over, and connects in action the whole arterial system, particularly in the brain, spinal marrow, and nervous system generally. It belongs principally to the heart itself, but through connections with branches of the par vagum, combines the nerves of this organ with those of the lungs, and those of the muscles of the chest. It combines the abdominal viscera, and these with the abdominal muscles. It animates and combines the reproductive organs; also the urinary organs, and connects these with sentient and voluntary nerves. It combines various other nerves and

Summary.

parts, through minute and intricate branches. It excites the organs it supplies, to separate from the blood and food such things as are prejudicial, whilst the absorbents retain the beneficial. As its ganglia have so much power over the circulation, they, with other nerves and processes, tend to the production of heat; they, also, through a somewhat similar influence, to that in the heart, tend to the persistence of action and want of weariness, even in the voluntary muscles of birds. It determines the effect that local injuries shall excite in the heart and blood-vessels, and the extent and power of constitutional irritation for their reparation.

CHAPTER VI.

THE CO-OPERATION OF THE PAR VAGUM WITH THE SYMPATHETIC.

As the par vagum and sympathetic are concerned in promoting the functions of organs connected in the completion of processes requiring their co-operation, the peculiarities of each will be briefly compared. Along with its perceptive faculty, the par vagum has considerable vital powers, but not so extensive as those of the sympathetic. The par vagum derives them from one larger source: the sympathetic derives a much greater aggregate quantity from numerous smaller ones. The perceptive faculty of the par vagum is greatest, on account of its concentrated origin from the oblong medulla; that of the sympathetic is less, not only on account of its origin from the spinal marrow, whose sensorial and perceptive powers are presumed to be much lower than those of the oblong medulla, but from its small connection at any particular point. There is no proof that any part supplied by the sympathetic is so acutely perceptive as the air passages, or as the stomach, compared with the intestines. On account of its high perceptive quality, it is employed in discriminative functions in the trachea, lungs, and stomach, and in fishes also, in the skin. It thus guards the lungs from receiving noxious air, and from sending impure blood to the heart, and guards the stomach from retaining noxious food, and from transmitting it to the intestines. The less perceptive quality of the sympathetic is

The Par Vagum and Sympathetic compared.

calculated for the more powerful acts of the circulatory system, as compared with the respiratory in the lungs themselves, and the more acrid process of assimilation, after an admixture with excretions, as compared with digestion. The par vagum, from its higher perceptive quality, has a greater power of controlling the muscular coat; the sympathetic, from its lower perception, allows more easily the less restrained peristaltic action of the intestines. The sympathetic is engaged more in the disposal of, than in the preparation of, the chyle for the blood, than in supplying blood for secretions. The par vagum is sparingly employed, both in the circulation and assimilation, but in amphibia it is more used for the circulation, as the perceptive quality of the sympathetic is dull, and, indeed, that of the nervous system generally. The perceptive faculty of the par vagum is sufficient for its simple object, but from its communications with the sympathetic, it may have its vital powers increased, and its accompanying blood-vessels more efficiently excited and connected with the blood-vessels of other organs. On the contrary, the branches of the par vagum may give high perceptive powers to parts supplied principally by the sympathetic, and particularly when their quality is low.

The oblong medulla may be influenced by the circulation which varies in each class of animals, the capacity of the heart and arteries affording a larger, and the quality of the heart a quicker, supply of blood. It is influenced by the quality of the blood, and can, therefore, independently of the par vagum, sympathise with the lungs, and excite the nerves of the respiratory muscles. Only such animals as have high faculties are under the necessity of respiring quickly, those with a small brain and more simple lungs can act with more deliberation. It may also be affected through the par vagum, by the

Independence of the oblong medulla.

several organs this nerve supplies, as with the heart, according to the proportion of branches it receives, also with the lungs and stomach, through their ample supply, but in a very slight degree with the intestines, as they have only a small proportion of it. It is only when the impulses are very strong or morbid that it is reached through the sympathetic nerve.

The heart is connected much less with the brain through the par vagum, in mammalia and birds than in amphibia. As the sensorial power is great in mammalia and birds, a larger communication with the oblong medulla, through the par vagum, might produce too much sympathy between the heart and the brain, and cause more blood to flow to this organ than is consistent with its functions. The heart is moderately connected with the lungs, as both organs require to act together, and to be in accordance with each other, and the oblong medulla. The heart is connected rather indirectly with the stomach and intestines through the branches of the par vagum descending on the œsophagus, and with the sympathetic through the cœliac plexus, so that it is more through the general impression arising from an impulse made on any portion of the par vagum, than through spinal communicating branches.

Par vagum and heart.

The lungs are connected with the par vagum that they may be under the influence of the oblong medulla. In accordance with the smaller size of the oblong medulla in amphibia and fishes, there is a great change in respiration, which is by far the most powerful in mammalia, on account of the large excitable brain in conjunction with a large body, the functions of which quickly deteriorate the blood. The oblong medulla, especially in mammalia and birds, feels directly the want of oxygenisation of the blood circulating in it, or much congestion in the large veins and viscera; amphibia do not feel

Par vagum and lungs.

this congestion in nearly the same degree, as they can wait a considerable time without respiring. The lungs are connected with the heart through the par vagum, that the impulse made on the right side of the heart and pulmonary artery may produce a sufficient perception, although it be only unconscious as in the stomach, to be communicated by the par vagum to the oblong medulla, from whence it may be conveyed to the nerves of the respiratory muscles, and excite them to action. Both the lungs and stomach are amply supplied by the par vagum, and readily sympathise, through the chords descending on the œsophagus, that digestion and respiration may be nearly proportioned to each other, that the oxygenisation of the blood may go on fast enough during assimilation, for perfecting and disposing of the chyle.

The stomach is freely supplied by the par vagum in the four superior classes, and the intestines in a much less degree; their stomach has less proportionate communications with the sympathetic than the intestines. The large supply of the par vagum allows the stomach to contract on the food for bringing it in contact with the exuding gastric juice, and gradually passing it through the pylorus; it allows the duodenum a slighter degree of the same power for mixing the food with the bile and pancreatic juice; the small quantity given to the continuation of the intestines produces a sympathy with the stomach and duodenum, whilst the chyme is propelled gently downwards by exciting the sympathetic. In amphibia, whose sluggish nature requires more excitement during digestion, the heart is more connected with the oblong medulla, that the brain may give its full power to the heart, and the heart equally support the brain and stomach with oxygenised blood during this process. The slower action of the heart diminishes

Par vagum and stomach.

the necessity for respiration, and in the same degree the appetite and digestion.

As the sensorial power is great in mammalia and birds, a larger combination with the heart through the par vagum might produce too much sympathy between the brain and stomach and the excitable heart, and cause more blood to flow to the stomach than is necessary for digestion, and more to the brain during this process than is consistent with its quietude. From the combination of the par vagum with the cœliac plexus, sympathy may take place between the stomach and the assimilating organs, the respiratory and the brain, and the heart only in a less degree. The heart is connected with the intestines through the sympathetic generally, and not through particular ganglia or branches, so that probably the presence of nutriment in the intestines, and the entrance of chyle into the circulation, produce only a general excitement of the sympathetic and of the heart from plenty of blood. The heart is thus more moderately excited than if it had been more largely combined with the stomach through the par vagum, or more directly with the intestines through the sympathetic; at the same time it is made to act more according to the produce of assimilation in the intestines, than of digestion in the stomach. In mammalia and birds the intestines and heart correspond more than the stomach and heart, as in amphibia. The connection of the stomach and intestines, especially through the par vagum, with the lungs, insures an adequate respiration so long as there is much chyle to be disposed of; but as this connection ceases a little beyond the cœcum, it is probable the contents of the intestines have then very little influence. The intestines are still more combined with the aorta and its arteries, than with the heart. The arteries, through the sympathetic, are more ready to receive

Modifications.

irritation from the intestines and other viscera supplied by the sympathetic than from the stomach which has so much more of the par vagum.

Par vagum and intestines.

Although some influence of the par vagum is continued beyond the stomach, the parts are chiefly supplied by the sympathetic. After the digestion of any portion of the food has been completed, and it has passed into the intestines, and become mixed with the bile and other secretions, nerves having a less perceptibility are necessary, and such as will produce a proper excitement in the intestines, but not convey any impression to the sensory except the food be very acrid, and then pain determines the actions of other parts for assisting to expel it. Nevertheless the branches of the par vagum not only produce a sympathy with the stomach and other organs, but may exercise some influence in the assimilative process, especially in some herbivorous animals, in which the food is soon transmitted into the capacious cœcum, where assimilation is carried on. The viscera would have communicated too much with the brain, and especially when this organ is large, if they had been wholly supplied by the par vagum, and particularly in the parts where the remains of the food have assumed a decidedly feculent character; therefore, according to this change, a diminishing proportion of this nerve is found, and at length the sympathetic only.

Sympathies of the par vagum.

It appears that the means of effecting sympathies between the stomach and other organs are modified in different animals by a varied but exact supply and combination of nerves. In one animal a small connection is sufficient, and a larger one would have deranged the degree necessary for balancing the several parts of the whole system. The stomach also sympathises with every part of the body through the dif-

fusive nervous influence. Any diffusive stimulus taken into the stomach immediately restores the action of the heart from its general effect on the nervous system, through branches of the par vagum in connection with the cœliac plexus, and through this generally with the sympathetic; but the more permanent effect is produced by assimilation and the reception of chyle into the circulation, and the heart and stomach have their uneasiness quieted until the blood is again wasted and deteriorated. The heart does not flag from want of food, but from want of the excitement of the brain and nervous system, which require nourishment, when their powers are exhausted either by a deficiency of oxygenised blood or by too much exertion. There are so many ways in which compensations are made, and through which sympathies take place, that they almost require a separate consideration in each animal.

Various sympathies.

There are great difficulties in any attempt to define the course of sympathy, and it is only when it is of a more mechanical and powerful kind that it can be attributed to direct connecting fibres of the centres in the brain, the oblong medulla, the spinal marrow, the ganglia and nerves. Excitement may be communicated through any of these to various parts of the body; also when it has begun in the immaterial parts of the nervous system, as the diffusive nervous influence, the instinct and mind. Sympathy may be general or particular. The general pervades the whole nervous system, and indeed the whole body; as when the diffusive nervous influence is acted upon through the instinct, or mind and understanding, and the exhilarating passions, or depressed by the uneasy or painful ones; or when exciting or depressing food and medicinal agents are administered. The particular sympathy affects one or more small centres or organs of the

body in connection with them through tracts and nerves. There is a difference, on account of the size and quality of the hemispheres of the brain and of the different portions forming separate centres, so that the lowest classes of animals cannot have large cerebral sympathies like those of man, therefore their small and simple centres cannot have their faculties much disturbed; but in the higher, if one part of the brain be disordered it receives a more lasting impression, and implicates others, which by reaction produce a complexity that with difficulty allows an entire restoration to ease and quietude. When the body is in health, and everything is properly balanced, sympathies will soon cease with their cause; but as there are variations of both original and acquired perceptibility and activity in several centres and organs, so these in a general excitement or depression may have their propensities encouraged and give rise to various more or less permanent disorders. On account of the lower perceptive quality, the sympathies of the parts supplied by the sympathetic nerve with those more especially connected with the sensory are less frequent, and less permanent, as there is so little power of reaction on it, and then only when there is a sufficiently high exciting cause, which is generally morbid. In amphibia the sympathetic is much more approximated to the cerebral and spinal nerves, as the sensorial powers are too low either to receive or communicate many offensive impulses.

THE END.

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